

AMERICAN CANCER SOCIETY
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"HEALTH HAZARDS OF RADIATION"
(A Panel Forum Recorded on Tape and Transcribed)

Linus Pauling, Ph.D., Professor of
Chemistry and Chairman of the Division
of Chemistry and Chemical Engineering
California Institute of Technology

Dr. Beadle: The next person on the program is Professor Linus Pauling, who is Professor of Chemistry, and Chairman of the Division of Chemistry and Chemical Engineering of the California Institute of Technology. Professor Pauling knows a great deal about the molecular structure of the materials that are important in the cells of our bodies - for example, the proteins and the nucleic acids. He has, perhaps, done more in research in this field than any other one person one could name. He is going to talk a little bit about the effects of radiation in terms of the kinds of molecules that are found in our cells. PROF. PAULING:

Dr. Pauling: Ladies, Gentlemen - You and I are interested in people. In particular, let me say that we know how hard the members of the medical profession are willing to work in order to save someone's life; and the American Cancer Society is working, and very effectively, to keep people from dying of cancer - a very good job.

Now, the use of radiation has been a great contribution in this fight against disease - we all recognize it. X-radiation used in the control of cancer, say, and the radioactive isotopes, too, are very valuable aids to man in the fight against disease; and yet, we have to recognize that radiation is dangerous. Only recently, it has become clear that even small amounts of radiation are dangerous. I believe that it would be possible for us to save thousands of lives each year, to keep a thousand people in the United States from dying of cancer each year, if we tried to do it. I have no doubt - I am a scientist and I think my mind is always open - and yet, I will say I have no doubt that small amounts of radiation are harmful.

For one thing, radiation causes mutations. 2% of the children born are seriously defective because of bad genes. According to the estimate of the National Academy of Sciences, the fall-out, for example, may increase this percentage by a small amount. Now, let's say the increase is not as much as 2% but, perhaps, 1%. There are 75 million children born in the world each year. $1\frac{1}{2}$ million of them are seriously defective; about 300,000 with serious mental defects, the others with serious physical defects because of bad genes. 1% increase in $1\frac{1}{2}$ million is 15,000 additional seriously defective children born each year.

GENETIC
EFFECT -
MUTATIONS

Now, if we can avoid this increase in the number of seriously defective children who are born, I would say it is worthwhile. It may be that this figure, 15,000, is not right; but I would fight just as hard about 1000 additional seriously defective children.

Now, what is the evidence about the damage to the pool of human germ plasm that is done by radiation? First, I may say that the geneticists of the world are united in expressing the opinion that damage to the pool of germ plasm is directly proportional to the amount of radiation, and that even minute amounts of radiation do this damage.

RELATION-
DAMAGE TO
DOSE

It is true that experiments with 25R may be the minimum that have been made directly, but it has been found that if this 25R is spread over a long period of time, the effect is the same as if it is concentrated into one slug. With the ordinary effects, radiation sickness for instance, this is not true. Thus, 500R will usually kill a man if he receives it in one dose, but if he receives it in small amounts, it does not.

The same thing is true - as shown by Dr. Hardin Jones - of the shortening of life expectancy by radiation. The same thing is true, apparently, of the production of bone cancer and of leukemia. There is some evidence that these effects occur (as the result of an accumulation of exposure to radiation).

We can understand it, too. If we have cells and little bullets of radiation go through them, they smash the molecules, damage the molecules. Most of the molecules are not very important. The damaged ones may be poisonous though, and if enough radiation goes through you, 500R, then you will die from radiation sickness because of these poisons.

RADIATION
SICKNESS

But a few of them - molecules of deoxyribose nucleic acid - are very important. These are the ones that determine the characteristics of our children. If just one of these is damaged, and it is a bad gene, and if the child inherits two bad genes, he may be seriously defective, may have a lethal defect, and die.

DEFECTIVE
GENES

Some of these deoxyribose nucleic acid molecules are the ones that determine the nature of the cell. When one of them is destroyed, and the cell is damaged, that cell may produce a cancer, may cause leukemia, bone cancer or some other disease, which leads to shortening of life. So we can easily understand how this significant effect of even a minute amount of radiation may occur.

CARCINO-
GENIC
EFFECT

At the present time in the United States, about 3R is estimated to be the average amount of radiation in over a period of 30 years from medical X rays, that people receive - therapeutic and diagnostic. Of course, there is very great value to the use of these X rays, but if an additional unit per person is used, and no additional result is obtained; or, expressed the other way, if, by being careful, we could cut down the average amount of exposure per person by one unit, then we would prevent the formation of thousands, hundreds at any rate, (very hard to estimate these quantities because we don't have really quantitative information), of cases per year of leukemia, cancer caused by this radiation.

The fall-out radiation that Dr. Lawrence has mentioned is quite small compared with the amount of medical X-radiation. It is my opinion, as I suppose many of you know, that we are being subjected to exposure to fall-out radiation uselessly - that the real problem is not to prepare for a devastating nuclear war (that can well destroy the world) but, rather, to avoid a nuclear war; and that we should start out by stopping tests, limiting armaments, achieving effective international control that avoids war. APPLAUSE

FALL-OUT

I believe that we should recognize that even small amounts of radiation are harmful. We should take this, not as a problem that makes us hysterical, but as a problem that we try to solve.

We should have, as part of our program, that of cutting down on the unnecessary use of X-radiation for medical purposes. Always, of course, use X-radiation when it is necessary, but try to minimize the amount. I know that the radiologists have been doing this, but many of them I know are skeptical about what I consider to be a fact - that even small amounts of radiation have a chance of producing serious somatic damage, as they produce the genetic damage. I think that if they were not skeptical, but accepted this, then they might well be somewhat more careful.

MEDICAL
USE

I think that even the relatively small amount of fall-out radiation is something that we can afford to think about to see whether we need to sacrifice the people it affects. If we take Dr. Lewis' estimate of the incidence of leukemia by radiation, Dr. Libby's statement about the equilibrium amount of strontium-90, and the factor, 10 or 15, for the strontium-calcium absorption ratio (I have forgotten that ratio) - take factor 13 for this ratio - we can calculate that one superbomb will cause 10,000 people to die of leukemia. (See Dr. Langham's talk. Editor's note)

LEUKEMIA
FROM
FALL-OUT

Now, there is some uncertainty about all of these calculations. I can't say that this is exactly right by any means, but I do want to communicate to you the feeling that I have that individual human beings are important, that this new kind of damage that strikes at random here and there - when the little bullet of radiation happens to hit in one human being the molecule that will cause trouble either to him or to some descendant of his perhaps many generations later - that this sort of phenomenon needs now to be given serious consideration.

CHOICES

APPLAUSE

Dr. Beadle: Thank you, Professor Pauling. As a moderator, I would like to say that perhaps there is one area on which the two speakers who have just presented their summaries can agree. That is, that all unnecessary radiation should be dispensed with. The argument is, "What is necessary", and "What is unnecessary".